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CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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SECURITY INFORMATION

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COUNTRY	USSR (Leningrad Oblast)	REPORT	[redacted]
SUBJECT	Development Work of Radar Laboratory No. 10, NII 49, Leningrad	DATE DISTR.	16 September 1953
		NO. OF PAGES	22
DATE OF INFO.	[redacted]	REQUIREMENT	[redacted] 50X1
PLACE ACQUIRED	[redacted]	REFERENCES	[redacted]

50X1-HUM

THE SOURCE EVALUATIONS IN THIS REPORT ARE DEFINITIVE.
THE APPRAISAL OF CONTENT IS TENTATIVE.
(FOR KEY SEE REVERSE)

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[redacted]

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2. The Soviet engineer referred to on page 2, paragraph 3, as Dubrovsky should be spelled Dubrovskiy.

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STATE	#x	ARMY	#x	NAVY	#x	AIR	#x	FBI		AEC		OSI Ev	x		
												[redacted]			

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(Note: Washington Distribution Indicated By "X"; Field Distribution By "#".)

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REPORT [redacted] 50X1 50X1-HUM

COUNTRY USSR

DATE DISTR. 17 AUG 53

SUBJECT Development Work of Radar Laboratory No. 10, NII 49, Leningrad

NO. OF PAGES 5

PLACE ACQUIRED [redacted]

NO. OF ENCLS. (LISTED BELOW) 50X1-HUM

DATE ACQUIRED

SUPPLEMENT TO REPORT NO.

DATE OF I[redacted]

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THIS IS UNEVALUATED INFORMATION

[redacted]

1. [redacted]

2. [redacted] Scientific and Technical Institute #49 (NII-49). [redacted] NII 49 was administered under the MSP organization. The Institute was 10-15 kilometers from Kusnve-ovskava Ulz. #18, and had formerly been a hospital. [redacted] NII 49 had been at this location since 1928, [redacted] that previously, at another site, the Institute had developed super regenerative radio receivers.

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3. SHARIN was the Soviet technical head of NII 49; the deputy engineer was a Soviet named DUBROVSKY. SLADKIN, a Soviet, was the technical head of Radar Laboratory #10. SLADKIN wore civilian clothes as did all the other Soviets who were assigned to NII 49. [redacted] SLADKIN was actually a military man assigned to duty with Radar Laboratory #10. [redacted] There was no German administrator, either technical or otherwise, in Radar Laboratory #10. There were about 70 Soviets assigned to the laboratory. The Soviets were all working on radar developments in the three- and ten-centimeter bands. Dr. WOLFF [redacted] worked on [redacted] assigned projects, independently of the Soviets except when [redacted] asked to help out on some particular problem. Dr. WILDE was assigned to a vacuum tube developmental laboratory in another part of NII 49. Here he was in charge of the spectrographic examination of vacuum tube materials. In addition he was assigned a development project in connection with traveling wave guides. WILDE wanted to discuss this project with Dr. WOLFF [redacted] since was somewhat out of his field. However, the Soviets would not allow this, so WILDE and WOLFF [redacted] discussed it privately. All of the other Germans were assigned to work dealing with servo-control devices and electro-mechanical computers, under the leadership of Ing. Herbert MUMMERT. [redacted]

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4. There were four divisions of Radar Laboratory #10 which were: an antenna division, a receiver division, an impulse division, and a planning division. Dr. WOLFF, Ing. NIELBOCK, two Soviet technicians, one Soviet mechanic [redacted] constituted a sort of subdivision to the planning division. [redacted] concerned [redacted] with dm range instrumentation problems, under the administrative direction of BISTROV, a Soviet, was head of the planning division. A Soviet liaison officer was also assigned [redacted] At first, this position was filled by a woman, Mrs. Lyubov NIKOLAYEVNA. She did not prove very satisfactory, however, due to her lack of a technical background, and Ing. MARTINOV, a man, was assigned to replace her.

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5. During the first month, absolutely nothing was done by the WOLFF subgroup. [redacted] no assignments, and had nothing to do. After this period [redacted] assigned work, and a chronological listing of the projects of this subgroup is listed below.

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a. Absorption power meter. This was for the thirty centimeter to six meter range. It had been designed previously by Dr. WOLFF [redacted] in Berlin. In Leningrad [redacted] ordered to build it again. When it was completed, a cabinet maker housed it in a fancy case and the instrument was then removed from the laboratory. One and a half years later it was returned [redacted] for calibration. The purpose of the instrument was to check the performance of radar transmitters. [redacted] This project took the subgroup about two weeks. /Enclosure (A) shows the circuit diagram of this instrument./

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b. Frequency stabilized micro-wave generator. [redacted] worked on this project for about one month. Then SHUPTA, who had been the administrative head of the WILKE group at MSP Berlin, [redacted] visited [redacted] Two days

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 [redacted] 50X1

later the project was cancelled. Dr. WOLFF [redacted] thought 50X1-HUM
that there might have been some connection between the visit of SHUPTA and the cancellation, and that it could have been done in order to keep certain information about auxiliary equipment from the Germans which the Soviets would eventually have had to place at [redacted] disposal in order to complete the 50X1-HUM
project. About this time Dr. WOLFF [redacted] found, in a 1947 50X1-HUM
issue of the Proceedings of the Institute of Electronic Engineers, an article by POUNDE, which described a very elegant 50X1-HUM
method of securing this stabilization. The Soviets immediately took the periodical away [redacted] the Soviets were already working on this modification [redacted]
/Enclosure (B) shows the circuit diagram of this device./

c. The first big task assigned to Dr. WOLFF [redacted] was the parallel 50X1-HUM
development of two devices. The first was a signal generator for the 9-13 centimeter band. [redacted] first made use of a "light- 50X1-HUM
house" tube. /This tube apparently is simply a triode with the plate connection being made to a terminal at the top of the ceramic envelope./ The Soviets later [redacted] substitute a GE 50X1-HUM
klystron, and this change set [redacted] back six months. /Enclosure 50X1-HUM
(C) shows the circuit diagram of the device./

d. The parallel development was a heterodyning frequency meter for the 9-13 centimeter range. [redacted] spent about 18 months on the 50X1-HUM
development of these two devices, which were to be used in testing a 9-13 centimeter band radar receiver. [redacted] 50X1-HUM
50X1-HUM
[redacted] Dr. WOLFF [redacted] 50X1-HUM
simply told that [redacted] device must cover the 9-13 centimeter 50X1-HUM
range. /Enclosure (D) shows the circuit diagram of the heterodyning frequency meter./ [redacted] 50X1-HUM

[redacted]

e. Impulse tube test set. This work order had originated from a vacuum tube factory in the Leningrad area. [redacted] 50X1-HUM
[redacted] This device enabled 50X1-HUM
the data for the determination of the characteristic curves to be taken simultaneously for 10 tubes. These tubes were for use in a pulse circuit transmitter. [redacted] 50X1-HUM
[redacted] Ing. NIELBOCK built the device. /Enclosure (E) shows the 50X1-HUM
circuit diagram of this set./ The tubes to be tested were the Soviet Zone copies of the RCA 829 B (double pentode) tube which had been sent to Leningrad from Berlin. [redacted] 50X1-HUM
[redacted] about 80 per cent of the tubes tested failed to meet the specifications. Circuit data was not recorded, but was taken visually by 10 operators. Provisions were made for a variable plate voltage from 0 to 5,000 volts, a variable screen grid voltage from 0 to 3,000 volts, and a variable grid voltage from -200 to 0 volts. A signal which was repeated about every 1,000 microseconds was placed on the grid for one microsecond. [redacted] 50X1-HUM

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[redacted] the transmitter in which these tubes were to be used [redacted] was a radar transmitter of some sort. 50X1-HUM

f. A similar test set for testing only one 687 RCA tube. [redacted] 50X1-HUM

g. Stabilized power supply for a 50 cycle source. [redacted] this was for use in a one kilowatt field radar installation. [redacted] 50X1-HUM The power supply was to be portable; apparently, by three men and a boy, since it would have taken a truck to carry it around. [redacted] transformer calculations on the basis of information [redacted] on certain German transformer core material [redacted] this material was to be used. When [redacted] building it, some material of magnetic characteristics, [redacted] and of Soviet origin, was supplied, and consequently the power supply did not operate as computed. [redacted] /Enclosure (F) shows the circuit diagram of this device./ 50X1-HUM 50X1-HUM 50X1-HUM 50X1-HUM

6. At the end of this project /see g., above/ the special instruments group of Radar Laboratory #10 was dissolved. This occurred in the summer of 1949. Dr. WOLFF, Ing. NIELBOCK [redacted] were transferred to the servo-mechanism section of the control and computing device laboratory. 50X1-HUM 50X1-HUM

7. Practically all of the important American periodicals in the electronic field were available to the group. [redacted] request a specific number through [redacted] Soviet liaison representative, MARTINOV. However, si[redacted] never allowed in the library, or were told what periodicals were available, [redacted] use of the library was limited. 50X1-HUM 50X1-HUM

8. [redacted] NII-400, to which [redacted] Dr's. KROCHMANN and SCHMIEDECK were assigned. Immediately after arriving at Radar Laboratory #10, material difficulties arose. [redacted] greatest difficulty in securing the proper ceramic resistors. They finally had to be secured from the firm of Dralowid in Berlin/Teltow. [redacted] th[redacted] of this firm was much poorer in quality even than in 1946.) In general the mechanical components, such as potentiometers, switches, relays, etc., were very good, while purely electrical ones were very poor. From 1946 to 1947, the situation was very bad. After 1947 it improved considerably; in 1948-1949 all [redacted] supplies were of Soviet manufacture. Until 1948-1949 all vacuum tubes were of USA manufacture. The Soviet tubes were direct copies of the American ones. The Soviets had USA germanium cyrstal detectors, GE klystrons, as well as U.S. Army Signal Corps frequency meters, type BC 101. RCA and Hickock vacuum tube voltmeters, as well as multitesters were available. The Soviets als[redacted] had a Hewlett-Packard frequency analyzer and signal generator [redacted] Soviet oscilloscopes with a 25-30 centimeter diameter, green trace screen were available in Radar Laboratory #10. These had a syncronizing circuit, [redacted] were is[redacted] them some time in 1948. 50X1-HUM 50X1-HUM 50X1-HUM 50X1-HUM 50X1-HUM 50X1-HUM

[redacted]

[redacted] Comments: The information mentioned in paragraph 5, item d., concerning the prior development, over that in the US, of a signal generator and frequency meter for the nine to 13 centimeter band, may or may not be of significance. It probably is not, due to the probability the US development was on a commercial scale, while that of Radar Laboratory #10 certainly was not. The information contained in paragraph 5, item e., wherein a tube testing device is described utilizing 10 operators as simply meter readers, might point to a shortage of electrical recording instruments in the USSR.

[redacted]

ENCLOSURE (A) Circuit Diagram of Absorption Power Meter

ENCLOSURE (B) Circuit Diagram of Frequency Stabilized Micro-wave Generator

ENCLOSURE (C) Circuit Diagram of Signal Generator

ENCLOSURE (D) Circuit Diagram of Heterodyning Frequency Meter

ENCLOSURE (E) Circuit Diagram of Impulse Tube Test Set

ENCLOSURE (F) Circuit Diagram of One Kilowatt Stabilized Power Supply

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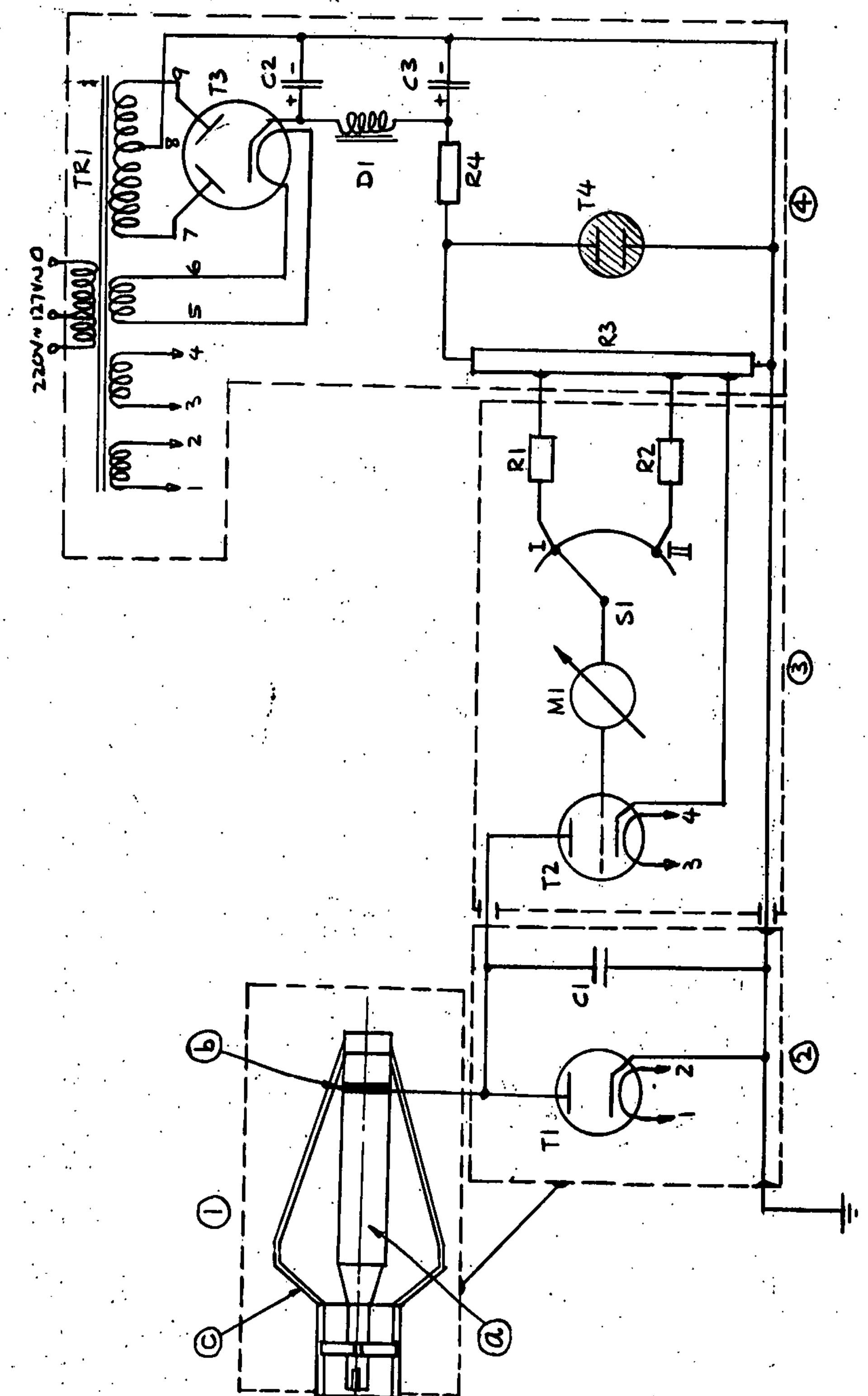

Circuit Diagram of the Absorption Power Meter

Enclosure (A)
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Legend to Enclosure (A), A Sketch of the Circuit Diagram of the Absorption Power Meter

1. HF resistance stage
   VSWR curve flat between 30 centimeters and 6 meters.

   a. Inner conductor is ceramic with a carbon coating of thickness one micron. Total resistance equal to R = 70 ohms, Dimensions - length = 50 centimeters; diameter = 6 centimeters; maximum power dissipation = 500 watts.

   b. Sintered Ag voltage divider contact, resistance ratio to total resistance = 1/10.

   c. Outer shield, exponential. Brass, Ag coated. The surface is given by the relation

$$Z_x = 60 \ln \frac{D_x}{D_1}$$

$$= R_x = pl \quad \text{where}$$

   L = total length = 50 cm
   Z_x = characteristic resistance
   D_x = diameter at distance x, measured from smallest diameter of shield
   D_1 = diameter of inner ceramic conductor

2. Peak Voltage Meter Stage

   T1 = LG1 tube (Diode, Telefunken)
   C1 = condenser, approximately 100 uuf

3. Inverse Tube Voltmeter Stage

   T2 = Type RL12P10 (Pentode - 1st and 2nd screen grids are tied to plate-effectively a triode)
   M1 = meter, 1 milliampere full scale. Calibrated in watts, according to

$$N \text{ watts} = \frac{V^2}{2R} \text{ (peak) where } R = (1) \text{ a.}$$

   R1 and R2 are resistances selected to give above ranges.

   S1 = range selector switch: position I = 0 - 50 watts
   position II = 0 - 500 watts

4. Stabilized Power Supply Stage

   TR1 = transformer; primary windings tapped for 127 and 200 volts at 50 cps. Secondary winding, 1 - 2 are filament supply for T1; 3-4 are filament supply for T2; 5 - 6 are filament supply for rectifier tube, T3 (5Z4 is the Russian designation) 7 - 8 - 9 is a center tapped plate voltage supply, giving -400 - 0 - 400 volts for T3.

   C2 = electrolytic condenser = 8 uf
   C3 = electrolytic condenser = 4 uf
   D1 = choke coil = 25 h

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R4 = 1000 ohms
T4 = 2 gas voltage regulator tubes, 150 being the ignition voltage with i_p = 60 mA
R3 = wire wound resistor, 3 taps, 2000 ohms, 10 watts

REMARKS: Chassis from stage (3) to (4) highly insulated.
Stages (1) and (2) assembled as one unit.

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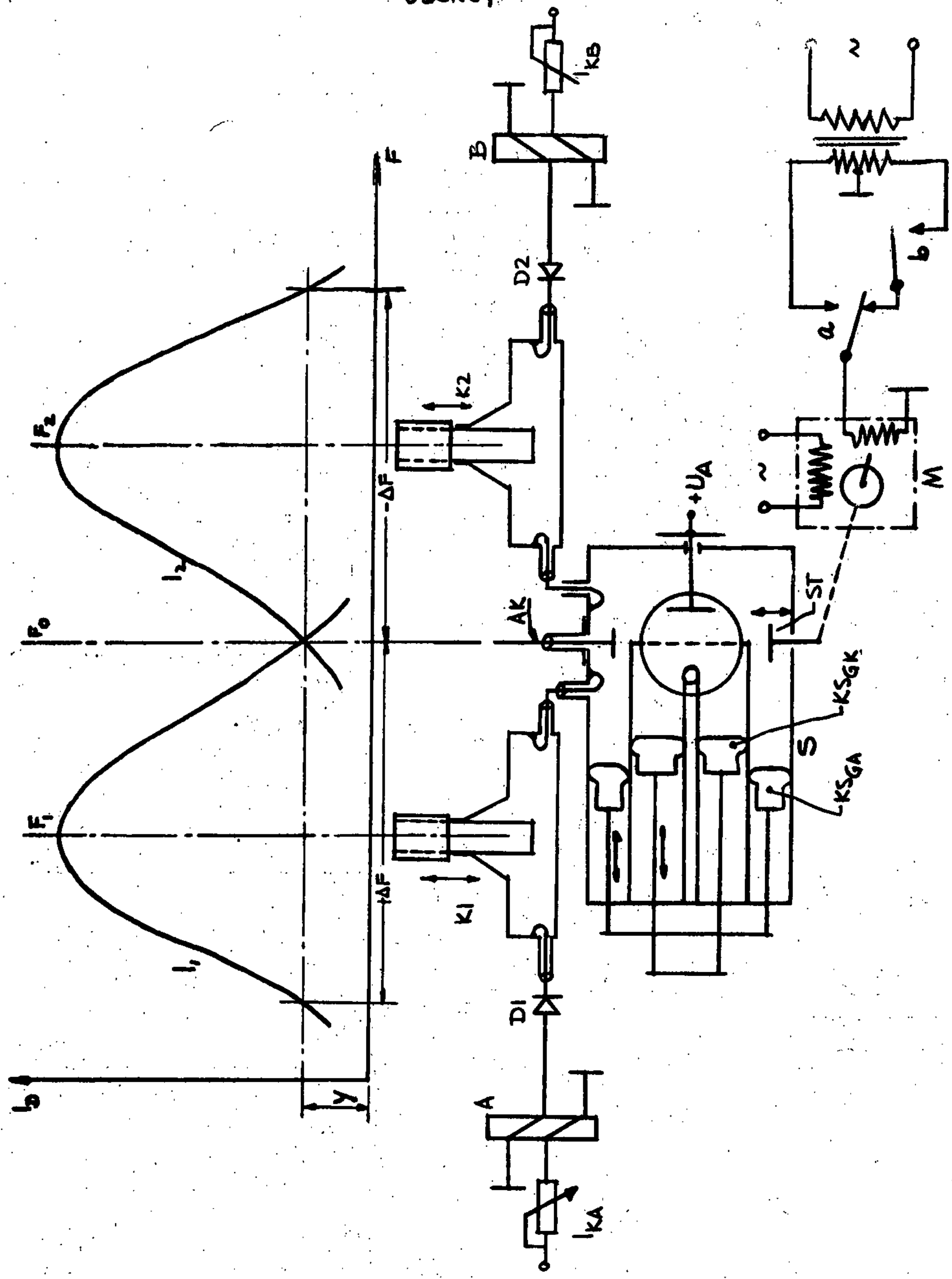

Circuit Diagram of Frequency stabilized Micro-wave Generator

Enclosure (B) page 1 of 2

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Legend to Enclosure (B), A Sketch of the Circuit Diagram of the Frequency Stabilized Micro-wave Generator

K1 and K2 = Tank circuit regulation, tuned by micrometer head.

S = 10 centimeter wave generator. LD12 (Telefunken), tuned by movement of external ring.

KS_{GA} is the grid-plate plunger

KS_{GK} is the grid-cathode plunger

ST = correction plunger for balancing of frequency.
U_A = plate voltage (insulated from ground)

M = low power induction motor for mechanical operation of the correction plunger ST.

D1 and D2 = cyrstal detector, silicon, Soviet copy of SYLVANIA.

A and B = polarized relays, Soviet copy of SIEMENS (not too good)

a and b = contacts for left-right motor control (direction of rotation)

I_{KA} and I_{KB} = potentiometers for regulation of compensation current and regulation of response value Y.

I_D = Detector current I_1 and I_2.

F_o = Rated frequency of generator, 10 centimeters.

F1 and F2 = tuning frequency of tank circuits.

AK = Generator output voltage.

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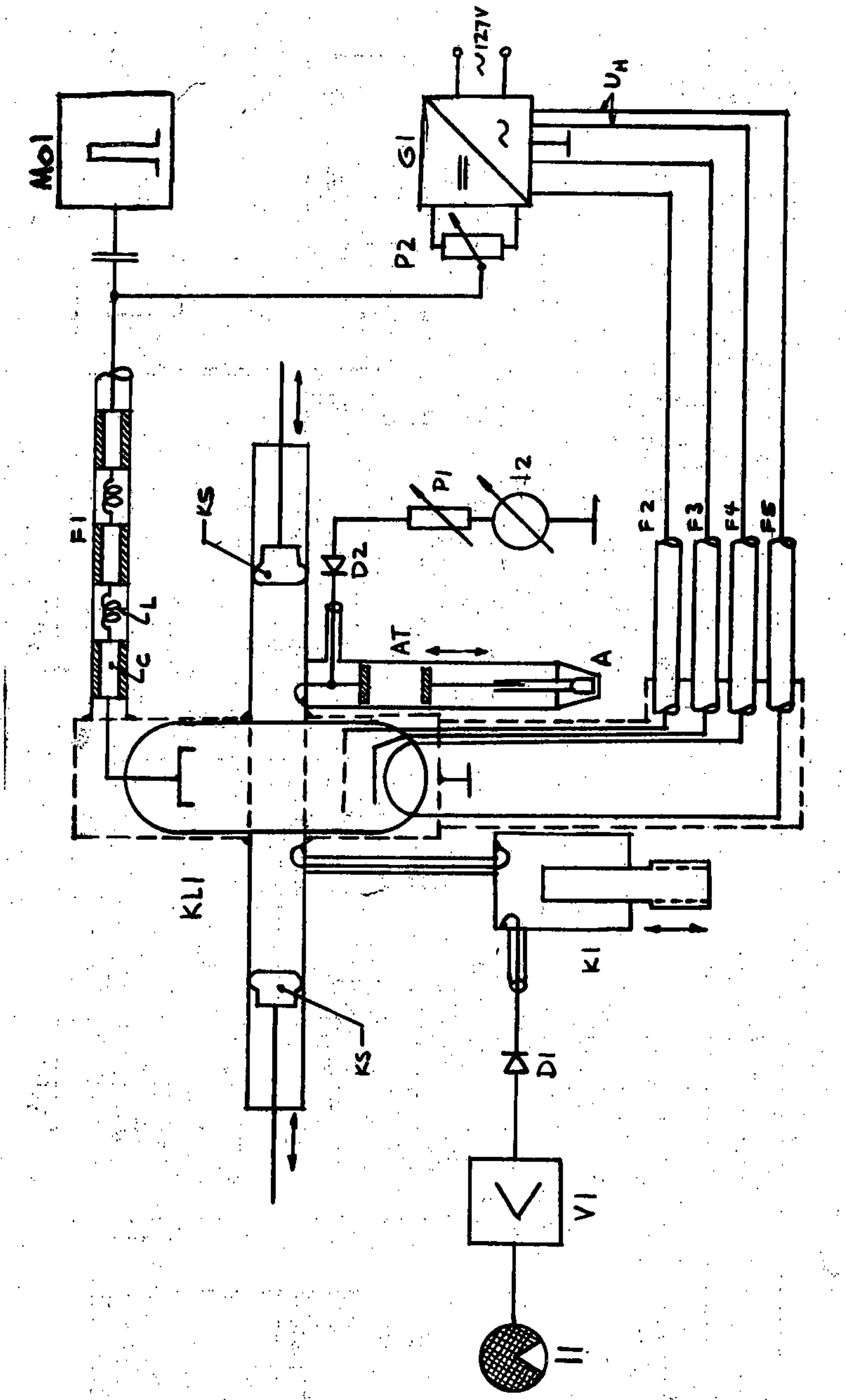

Circuit Diagram of Signal Generator

Enclosure (C) page 1 of 3 50X1

Legend to Enclosure (C), a Sketch of the Circuit Diagram of the Signal Generator

This was developed in three models:

Model I was a coaxial generator, utilizing the Soviet copy of the RCA tube type GL 446. This generator oscillated, but did not have the desired output in the 9 to 13 cm range (frequency ratio 1/1.45).

Model II utilized a Western Electric 726-A klystron. (The description of this model is presented below.)

Model III used a 726-A klystron utilizing an automatic stabilization of the output voltage over the desired range. This development was stopped after the successful completion of Model II.

In Model II, a bolometer bridge was designed for the absolute calibration of the output voltage, but was not incorporated in the design because the Soviets claimed it was not necessary.

Model II

KL1 = Reflex Klystron, Western Electric 726-A tube, with tunable, rectangular wave guides. Tuning by two simultaneously operated tuning plungers, KS. These were shaft driven gear chain drives.

F1 - F5 = CL filter chain for damping of parasitic HF voltages. They first tried chemical damping, but this was unsuccessful due to contaminated materials.

Mo 1 = Impulse modulator for selective impulse modulation of signal generator on reflector electrode. Impulse frequency was 1000 cps. (constant) Impulse width = 0.5×10^{-3} seconds. On-off times equal. Output voltage (peak) = 100 volts. Out resistance was low ohmic.

Mo 1 was a sine wave oscillator with one half of a 6N7 tube, operating at 1000 cps. 3 stage grid and plate limiter with ½ 6N7 plus 1 6N7 tubes and a cathode follower in the output stage.

K1 = Tank circuit absorption wave meter, tunable by plunger movement regulated by micrometer head. Range, 8.5 to 13.5 cm in wavelength.

D1 = Silicon detector. Soviet copy of SYLVANIA.
D2 = Silicon detector. Soviet copy of SYLVANIA.

V1 = Two stage, direct current amplifier with LOFTINWHITE circuit, manually operated potentiometer as input voltage divider.

I1 = Magic eye tuning indicator for wavemeter.

I2 = 20 uA meter movement. Taken from German directional receiver. Used for measurement of transmitter output power. Rated level indicated by red fiducial mark = 100 mWatts absolute.

P1 = Potentiometer, about 50,000 ohms for varying transmitter output power.

AT = Variable attenuater, hollow tube with sub-critical diameter, maximum damping 1 to 1,000. Attenuation by mechanical change of position of two condenser plates. Except for initial part of range, damping is linear and a function of plate separation. Approximately Nepers/cm if tube diameter is greater than the wavelength.

A = Concentric output connection. Output resistance = 50 ohms, maximum output power, approximately 100 watts.

Gl = Rectifier, with voltage stabilization and wave band LC filter. Supply voltage for Ul, KLl, and 1. Grounded.

P2 = Potentiometer for regulation of reflecter voltage of klystron. Range of regulation, 120 to 150 volts. By this means, a fine adjustment of the signal generator frequency is possible. The klystron operates on the first oscillation. Voltage on the tuning wave guides KS, is 300 volts, with positive grounded.

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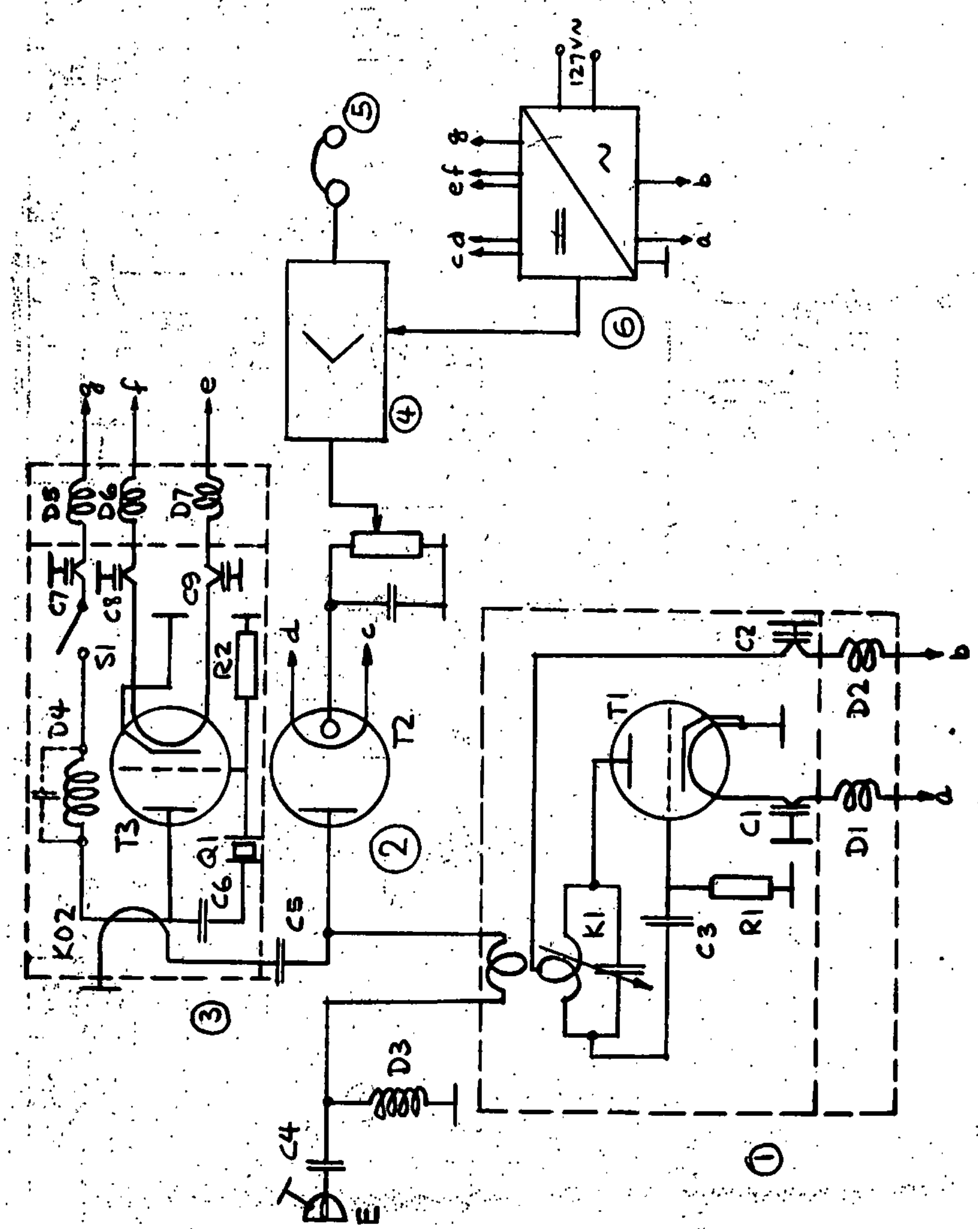

Circuit Diagram of Hetrodyning Frequency Meter
Enclosure (D) page 1 of 3

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Legend to Enclosure (D), A Sketch of the Circuit Diagram of the Heterodyning Frequency Meter

(1) = Variable band width oscillator stage. Range approximately 400 to 600 megc. Output amplitude for basic range = 15 volts (constant).

T1 = Soviet copy of RCA acorn tube, type 955. Oscillator with C3 and R1 designed such that the output voltage has a high harmonic content.

C3 = 50 uuf, and R1 = 20,000 ohms.

K1 = Oscillating circuit, coaxial butterfly with single-slotted tubes, silvered. Tuning by means of precision dial, ratio 1 to 1,000. Fine and coarse scale. More or less slot coverage by Ag plated brass plates, operated by means of external thumb screw. This makes possible a correction so that the calibration curve is linear.

C1 and C2, condensers = 100 uuf each.

D1 and D2, high frequency filter chokes. Oscillator is effectively screened and grounded.

a = filament voltage from power supply 6
b = plate voltage from power supply 6
(both stabilized for 150 volts)

Ko 1 = Oscillator output coil. By experiment, the band pass filter characteristics in the range of 2,000 to 3,000 megc is achieved. By this means the 5th harmonic of the oscillator is formed.

(2) Mixer stage with T2 double diode made by Loren$_z$ (Type RD24G$_a$)

E = input connection for unknown frequencies.

f(x) = 70 ohms normal connector.

f(x) is mixed with the 5th harmonic of the wide band oscillator.

C4 = 10 uuf

D3 = high frequency choke

C10 = 500 uuf
P1 = 1 meg ohm (acts as volume regulator for (4).

C5 = Coupling condenser approximately 10 uuf

c and d are heating filaments for diode, from power supply (6).

(3) Quartz generator - 19 megc

T3 = Double diode, 6J6 (RCA) ½ only used

Q1 = 19 megc quartz crystal, obtained from WW II radar installation (German code name was FREYA)

C6 = 5,000 uuf condenser

R2 = 100,000 ohms

C7, 8, 9 = condensers, 100 uuf

D5, 6, 7 = high frequency filter chokes

D4 = high frequency coil as outer resistance. Designed so that the inter-turn capacity resonates from the 22 to the 32 hormonic of the quartz crystal.

Ko 2 = coupling coil

S1 = Switch, for calibration and measurement. In CAL. position the plate voltage for the quartz oscillator is turned on.

(4) Selective, 2 stage amplifier. RCA 6SJ7 tubes. Resonate frequency 100 cps.

(5) Earphone as tuning detector.

(6) Power supply, stabilized. Supplies operating voltage for (1), (2), (3), and (4).

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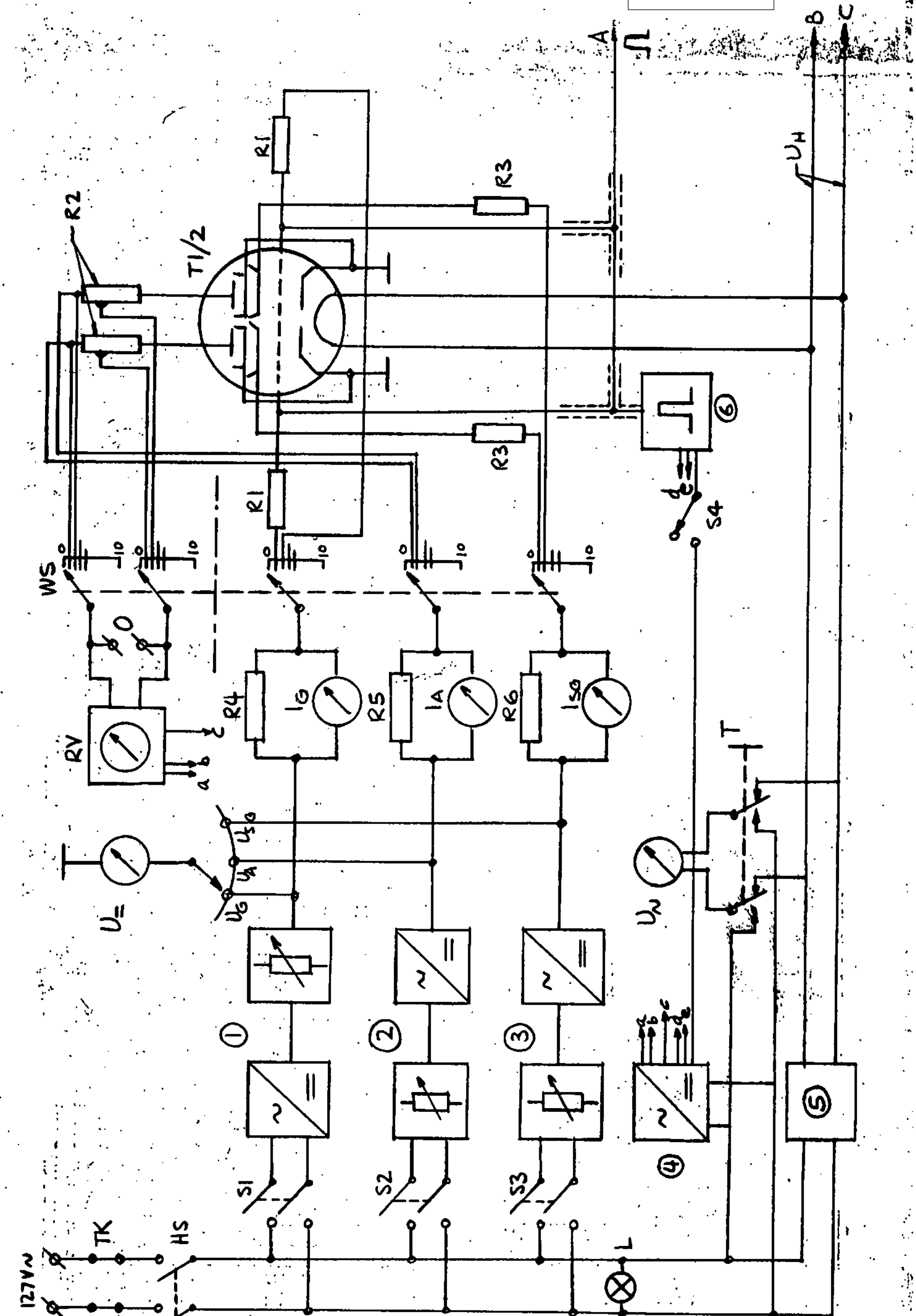

Circuit Diagram of Impulse Tube Test set
Enclosure (E) page 1 of 3

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Legend to Enclosure (E), a Sketch of the Circuit Diagram of the Impulse Tube Test Set

Two models were developed.

First, a tube testing instrument for five, double pentode tubes. These were the Oberschroeneweide (OSW) copy of the GE 829 B tube.

Second, a test set for a single Soviet copy of the RCA 6AC7 tube. This was a table model. The circuit diagram is the same for both models, except that in the second model, the tube heating filament could be regulated.

Data for the power supply corresponds to the operational data for the 6AC7.

Impulse generator built for the 6L6 RCA tube.

TK = door contact, safety device.
HS = double pole, single throw main switch.
L = power indicator lamp, 127 volts.
S1 = double pole switch for grid voltage box.
S2 = double pole switch for plate voltage box.
S3 = double pole switch for screen grid voltage box.

(1) Grid voltage rectifier with filter circuit. Full wave rectification, using 5Z4 (Soviet designation) tubes. Voltage regulation of DC voltage from 0 to approximately 300 volts by means of a potentiometer.

(2) Plate voltage rectifier. Up to 5,000 volts on primary of transformer, similar to Variac as built by GE. High voltage auto transformer. Single wave rectifier tube, Soviet manufacture, for 5,000 volt rectification.

(3) Screen grid voltage rectifier. Up to 3,000 volts, also regulated from the primary side of the transformer, by auto transformer similar to Variac. Same Soviet-made rectifier tube for the 3,000 volt supply.

(4) Rectifier for rectifier and heater voltage. For the impulse generator and impulse tube voltmeter, RV. Full wave rectification with Soviet 5Z4 tube. Maximum DC voltage approximately 250 volts.

(5) Ferromagnetic stabilizer for stabilizing heater voltage of test tubes, 829 B. 50 watts power.

U = alternating controlled instrument for power and heater voltage control. By calibrated resistances, the rated values for the power and heater voltages are indicated by a red mark.

T = Shift key for closing power supply voltage circuit. Heater voltage constantly indicated.

U_{DC} = direct current control instrument, 0 - 300 volts.
Position 1 - grid voltage
Position 2 - plate voltage
Position 3 - screen grid voltage

Through calibrated resistances, calibrated voltages are supplied for the working range of the tubes.

u_e = -120 volts = grid voltage
u_a = 3,500 volts = plate voltage
u_{SG} = 1,500 volts = screen grid voltage

I_G = indicator for grid current, five volt range, with calibrated shunts R4 (in mA) R4 approximately 100 ohms (shunt), calibrated in mA.

I_A = indicator for plate current, five volt range, with calibrated shunt, R5 approximately 10 ohms, calibrated in mA. Maximum current range approximately 200 mA.

I_{SG} = indicator for screen grid current. Five volt range. R6 approximately 10 ohms. Range = 100 mA. Calibrated in mA.

RV = impulse tube voltmeter, with 6SN7 RCA tube. One system connected as diode. Peak voltage rectification. Second system, DC amplifier. Indicator measures the plate current in the linear part of the characteristic transfer curves. Maximum input voltage approximately 100 volts.

O = connection box for oscilloscope.

WS = tube, selector switch. Five-stage, 11-position. One position is an open circuit position. The two switch stages for RV are shielded from the other stages.

(6) Impulse generator. Positive impulse frequency = 1,000 cps. Width = 1 microsecond. Output voltage approximately 150 volts (peak). Diagram of normal blocking oscillator, using 829 B tubes. Both systems connected in parallel.

(Point A) Supply for 10 grids, paralleled with output windings of input transformer. The impulse transformer core is of normal lamination design. All grid cables shielded. On and off switching is done by interruption of the plate voltage over S4.

T1 and T2 = One of five test tubes, 829 B, with two systems.

R1 = specified grid resistance approximately 50,000 ohms (this is for every system).

R2 = specified plate resistance approximately 4,000 ohms. For connection of the impulse tube voltmeter, plate resistance subdivided 1 to 10. Short leg, bifilar windings of 400 ohms.

R3 = specified screen grid resistance, applied as above. Value unknown to me.

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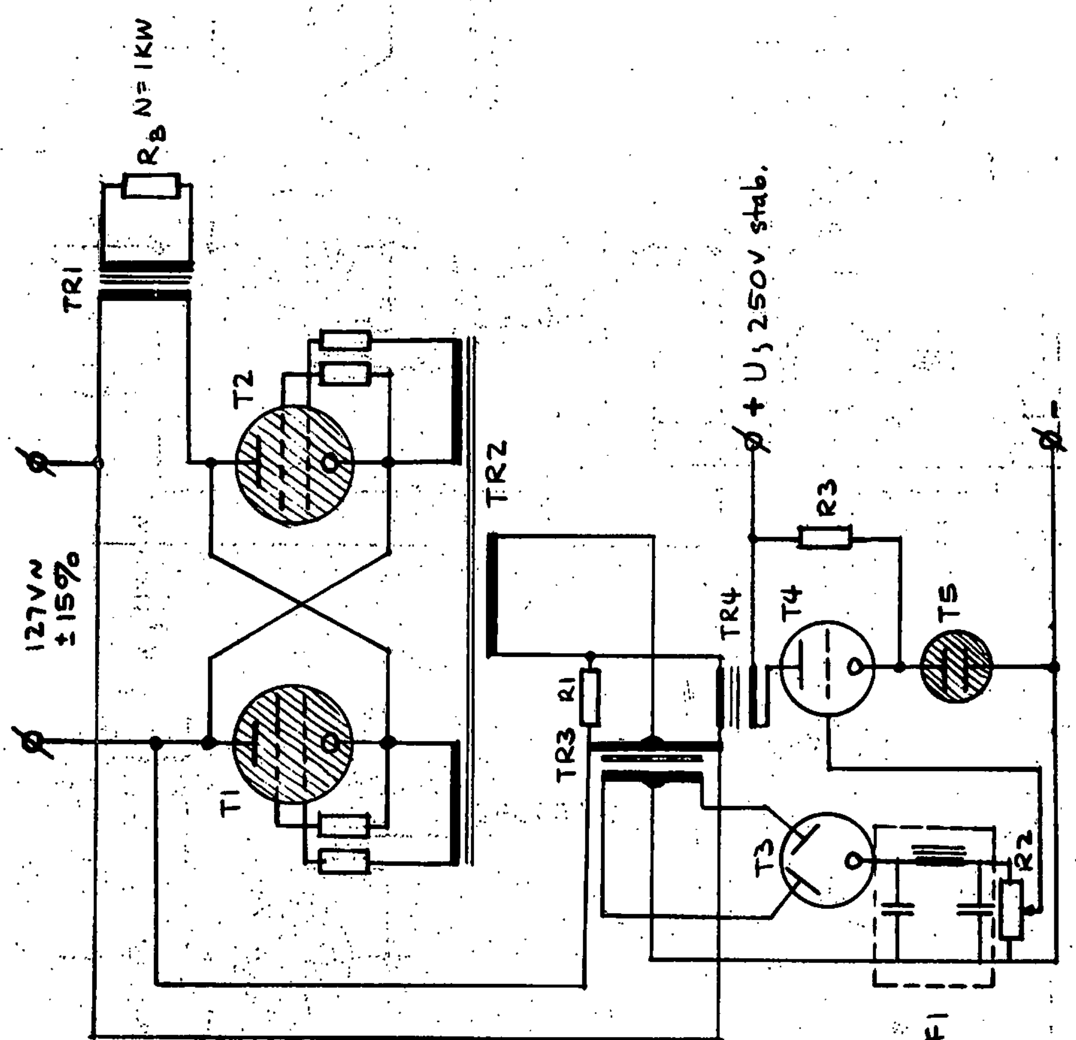

Circuit Diagram of One Kilowatt Stabilized Power Supply

Enclosure (F) page 1 of 2

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Legend to Enclosure (F), a Sketch of the Circuit Diagram of the One Kilowatt Stabilized Power Supply

T1 and T2 = thyratrons, maximum current, five amperes

TR1 = output transformer, 127/127 volts

R_B = ohmic load resistance

TR2 = transformer for supply of phase bridge, R1 to TR4 and for supply of control rectifier T3

TR4 = DC saturable reactor

T3 = full wave rectifier, 6X5 RCA tubes, (Soviet copies)

F1 = filter system

R2 = control potentiometer for setting working point of T4

T4 = half double triode. 6SL7 (Soviet copy) Voltage comparator stage

T5 = gas filled stabilizer tube. 150 volts, 30 mA maximum

R3 = initial resistance for T5, as constant reference voltage